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THEIR CONSTRUCTION, EQUIPMENT,
AND MAINTENANCE.

BY AUGUSTINE W. WRIGHT.

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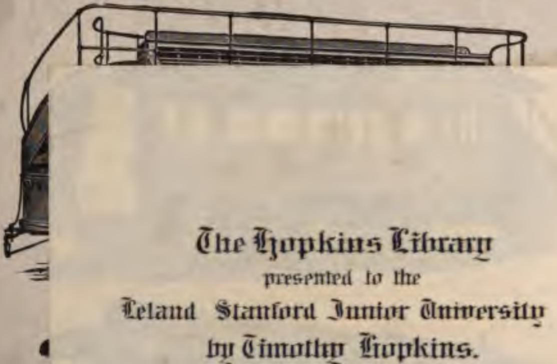

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AMERICAN STREET RAILWAYS:

THEIR

CONSTRUCTION, EQUIPMENT
AND
MAINTENANCE.

BY

AUGUSTINE W. WRIGHT,
CONSULTING ENGINEER.
MEMBER AMERICAN SOCIETY CIVIL ENGINEERS;
MEMBER WESTERN SOCIETY ENGINEERS.

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By Augustine W. Wright

DEDICATION.

To V. C. Turner, Esq.,

Late President North Chicago City Railway.

My Dear Mr. Turner: I take the liberty of dedicating to you the following pages, as a slight evidence of my appreciation of the kind advice and counsel with which you favored me during the entire term of my service with the North Chicago City Railway; as a token of regard for your worth as an individual and as a railway manager.

Sincerely, your friend,

Augustine W. Wright.

PREFACE.

The following pages were written from time to time, as moments could be taken from a busy professional life. They were gathered together, and, having appeared in the columns of the *Street Railway Gazette*, are now offered in book form, to meet a want evinced by those who have endeavored to obtain information upon these subjects.

My apology for issuing the book is that no one during the past twenty-five years has written upon this subject in the United States. The able work, "Tramways," from the well-known pen of D. K. Clark, treats of construction as practiced in Great Britain and upon the continent; which differs as widely from American construction as do the Steam Railway Systems of those countries. Having had nearly twelve years' experience upon Steam Roads, I served almost eight years as Chief Engineer, Superintendent of Track and Construction of the North Chicago City Railway, with the rare advantage of being under V. C. Turner, President, by whose able management the capital stock of that Company was advanced from $75 to $635 dollars per share.

Mr. Turner, during the twenty-seven years of his connection with that Company, in various positions, accumulated a fund of information that included every detail of Street Railway management. To his kind advice I ascribe any success I may have achieved.

Upon January 1st, 1887, it appeared from the best attainable information that there were 4,864 miles of street railway in the United States, upon which 20,392 cars were drawn, and 98,659 horses were employed, besides cables, etc. These roads are increasing yearly in number and in value, and it is hoped that the following pages may not be without benefit to their management.

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AMERICAN STREET RAILWAYS.

CHAPTER I.

TRACK CONSTRUCTION.

INTRODUCTORY.

The amount of capital invested in the street railways of this country is measured by tens of millions! Each street railroad official is endeavoring to get the *best* for the least money. The requirements for the different roads vary with the surroundings.

A track constructed in the busy streets of a great metropolis, having to carry, in addition to its own great traffic, a large portion of the general business of the city, should be built in a more substantial manner than the track in the street of a village where the traffic is proportionately less.

Few people, outside of the street railway officials, realize to what extent general traffic seeks the smooth way afforded by the rails, with lessened friction. On April 14th, 1881, I stationed a man with pencil and paper on North Clark street (in Chicago), between Elm and Division streets, for ten hours, from 7 a.m. until 12 m. and from 1 p.m. until 6 p.m., with directions to carefully count every vehicle that passed, and note those whose wheels traveled upon the horse railroad rails, those which used the sixteen feet of pavement the company has to maintain, without being on the rail, a those who traveled entirely outside the sixteen feet mentioned. He reported 2,052 vehicles upon the r cluding 642 cars), 61 vehicles upon the aforementio teen feet, but not on the rails, and 53 outside; cent of the street traffic at this time and place so following order: Oaks, pines, chestnut, hemlock, cedars, tamarack, cypress, elms, ash, cherry, black walnut, firs, spruce, beech, locust, redwood, maple, butternut, coffeenut, mulberry and mosquit."

The following table gives the average durability and cost of cross-ties to steam railroads, by Mr. Hough:

TABLE OF DURABILITY AND COST OF CROSS TIES.

KIND OF TIMBER.	AVERAGE.	
	Durability in Years.	Cost.
Oak	7.4	$0 41.2
White Oak	7.3	40.6
Post "	7.0	33 0
Burr "	7.4	37.3
Rock "	7.0	42 0
Red "	5.0	27 0
Chestnut "	7.1	28.0
Black "	4 5	43 0
Southern Pine	6.5	37.0
White "	6.5	31.5
Cedar, Red	11.8	34.0
" White	7.5	
Cypress	8.7	
Ash, White	4 3	
" Black	3.8	
Cherry	6 to 10	

The *Railroad Gazette*, December 26th, 1884, contains a valuable editorial upon the standard dimensions and woods of American (steam railroad) cross-ties, in which it appears that the following percentage of the various woods is used upon 90,900 miles out of 121,592 miles in operation:

White Oak	58.2	per cent.
Cedar	10.4	"
Yellow Pine	8.7	"
Northern Pine	6.9	"
Hemlock	5.9	"
Chestnut	4 4	"
Fir	1.7	"
Spruce	1.6	"
Cypress	1.0	"
Miscellaneous Soft Woods	0.6	"
Miscellaneous Hard Woods	0.6	"
	100	"

The durability of the same kind of timber varies.

1st. With the age of the tree. "The life of trees, like that of man, has been commonly divided into three stages —infancy, maturity and old age. In the first the tree increases from day to day; in the second it maintains itself without sensible gain or loss; but in the third it declines. These stages vary in every species according to the soil, the aspect, the climate, or the nature of the individual plant."

2d. With the time of year in which the tree is cut. It is generally conceded that the decay of timber is caused by the fermentation of the sap. The tree should, therefore, be felled when it contains the least sap.

3d. The timber should be seasoned before it is used. Air seasoning under a roof is the best. As a rule, my stringers and ties are piled up so that the air has free circulation about them for two years or over. Water seasoning in a running stream has been recommended from the time of Evelyn and Pepys. "The natural juices of the tree are removed by the water penetrating throughout its pores."

4th. The soil in which the tree grows affects its durability. Wood grown in a moist soil is lighter and decays sooner than that grown in dry, sandy soil. Its structure is not so compact and it contains more moisture.

The cross-tie of a street railroad has quite a different duty to perform from that of a steam railroad. In the street railroad the tie is not subjected to wear, as it is under the rail of a steam railroad. It is not so subject to decay, being protected by the pavement from the weather. It serves to support the track, and when angle irons are used, to hold the rails and stringers to gauge. I use cedar cross-ties, costing, this season, in Chicago, 27 cents each. My specifications are: Ties to be of sound cedar, sawed to
feet in length, six inches deep, and not less than six
face, sawed on top and bottom.

Sawed ties are considered objectionable upon
steam railroads, being thought not so durable, and
not as strong; but in street railway tracks it is
have a smooth, level surface on the cross-
stringer and give it a perfect bearing. I
much difficulty in obtaining ties hewed tru
I have adopted sawed in place of hewn
should, so far as possible, have equal wid

Other experiments that I find in engineering literature upon this subject are as follows:

Trautwine, in his Engineers' Pocket Book, p. 383, speaking of the adhesion of spikes, says: "Professor W. R. Johnson found that a plain spike, .375 or ⅜ inches square, driven 3⅜ inches into seasoned Jersey yellow pine or unseasoned chestnut, required about 2,000 pounds force to extract it; from seasoned white oak, about 4,000 pounds; and from well seasoned locust, 6,000 pounds.

"Recent careful experiments in Hanover, Germany, by Engineer Funk, give from 2,465 to 3,940 lbs. (mean of many experiments, about 3,000 lbs.) as the force necessary to extract a plain, one-half square inch iron spike, six inches long, wedge pointed for one inch (twice the thickness of the spike) and driven 4½ inches into white or yellow pine. When driven five inches, the force required was about one-tenth part greater. Similar spikes, nine-sixteenth inches square, seven inches long, driven six inches deep, required from 3,700 to 6,745 pounds to extract them from pine, the mean of the results being 4,873 pounds. In all *cases about twice as much force* was required to extract them from oak. The spikes were all driven *across* the grain of the wood. Experience shows that when driven *with* the grain, spikes or nails do not hold with more than half as much force.

"Jagged spikes or twisted ones (like an auger) or those which were either swelled or diminished near the middle of their length, all proved inferior to plain, square ones. When the length of the wedge point was increased to four times the thickness of the spike, the resistance to drawing out was a trifle less. When the length of the spike is fixed, there is probably no better shape than the plain, square cross section, with a wedge point twice as long as the width of the spike.

"Boards of oak or pine nailed together by from four to sixteen tenpenny common cut nails, and then pulled apart in a direction lengthwise of the boards and across the nails, tending to break the latter in two by a shearing action, averaged about 300 to 400 lbs. per nail to separate them, as the result of many trials."

Tredgold, in his "Principles of Carpentry," fifth edition, p. 180, article "Nails," says: "Nails are, in fact, pins made of iron, and the resistance they offer to being drawn is very considerable."

The following abstract of Mr. Bevan's experiments exhibits the relative adhesion of nails of various kinds when forced into dry Christiana deal, at right angles to the grain of the wood:

KIND OF NAILS	Number to the pound, avoirdupois.	Inches long.	Inches forced into the wood	Powers required to extract.
Fine Sprigs	4,560	0.44	0.4	2
Fine Sprigs	3,200	0.53	0.44	37
Threepenny Brads	618	1.25	0.50	58
Cast iron Nails	380	1.00	0.50	72
Sixpenny Nails	73	2.50	1.00	187
Sixpenny Nails	73	2.50	1.50	327
Sixpenny Nails	73	2.50	2.00	530
Fivepenny Nails	139	2.00	1.50	320

Weight in pounds required to draw a sixpenny nail driven in one inch into the below mentioned wood. Last column the amount of force in pounds.	Pounds.
Dry Christiana Deal	187
Dry Oak	507
Dry Elm	327
Dry Beech	667
Green Sycamore	312
Dry Christiana Deal, driven in endways	87
Dry Elm, driven in endways	257
(Thin sixpenny nails, at 73 to the pound.)	

It was further desirable to ascertain the degree of dependence that might be placed on nailing two pieces together, and Mr. Bevan kindly undertook to make some trials. Two pieces of Christiana deal, seven-eighths of an inch thick, were nailed together with two six-penny nails, and a longitudinal force in the plane of the joint, and consequently at right angles to the direction of the nails, was applied to cause the joint to slide; it required a force of 712 lbs., and the time was fifteen minutes; the nails curved a little and were then drawn.

"Another experiment was made in the same manner with dry oak, an inch thick, in which the force required was 1,009 lbs.; the six-penny nails curved and were drawn by that force.

"Dry, sound ash, an inch thick, joined in the same

[illegible] not take a firm bearing upon the [illegible] loaded car wheel comes up [illegible] will soon have play, and rapi

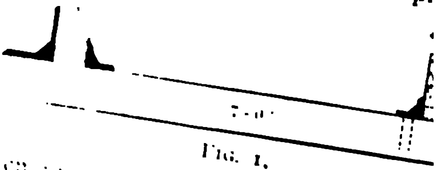


FIG. 1.

It has been [illegible] to fasten the rail ends [illegible] joint again [illegible] bolts, but this fastening, [illegible] allows the whole [illegible] the timber, [illegible] joint to vibrate under passing loads and wear into the wood.

I patented a joint fastening, as the result of my investigation, as follows: Chairs may be of steel, wrought or cast iron, corresponding in width and shape to the rail. Under the chair two or more nuts are let into the top of the stringer, beneath holes in the chair and rails. The chair is then put in place on the stringer, over those nuts through which holes have been bored in the stringer of less diameter than the hole in the nut. Suitable openings are provided in the chairs to allow contraction and expansion of the rails. The rails are then placed upon the chairs and a bolt screwed through the nut into the stringer beneath. The nuts fasten the rail ends to the chair, and they are thus held level with each other. The bolt below the nut is screwed into the timber and fastens the complete joint to the stringer.

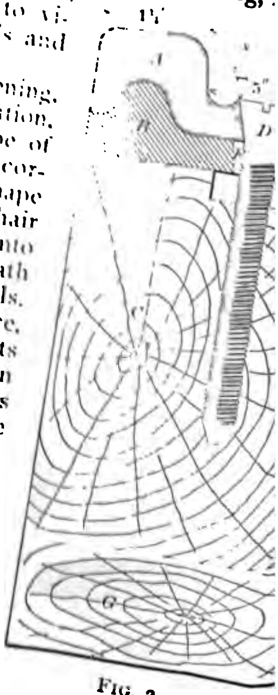
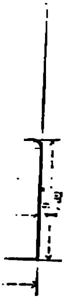


FIG. 2.



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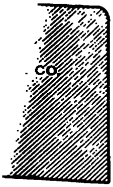

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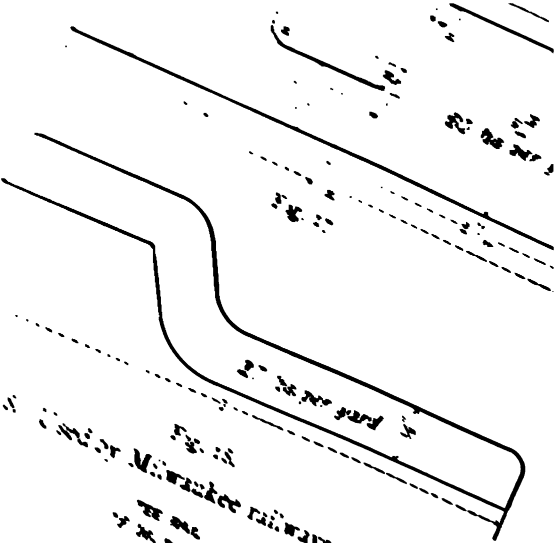


Figure 18. Girder for Milwaukee railways and elsewhere.

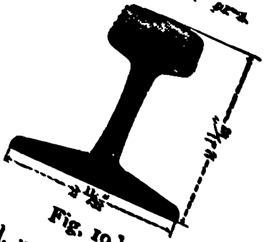


Figure 19. Tee rail, used on man
vns.

TRACK LAYING.

In the majority of instances the municipal auth require the tracks to be laid so as to conform accura the established grades, if the street be improved; if be level with the adjoining surface. Street railway nies will find it advantageous to have a competent e to set grade and center stakes. My practice is as f

Having obtained the heights of grades establis act of common council and line of street, I have oak stakes, two inches square, driven each 50 lin. f are for grade line. Their tops are driven to exa One for the center of track, and the precise point is i by a small tack. A gang of men under a sub- excavate trenches for the cross ties, he measuring wi 16 feet long and marking each four lineal feet. H ful to excavate deep enough, measuring from a l is tightly stretched from stake to stake. It is ea a tie, but a work of time and expense to *lower* stringers and rails are placed upon it. Anothe men carry and place the stringers upon the cros rails upon the stringers, being very careful neve *two* stringer joints (one on each side of the tr upon the same cross-tie, and never to have a rail j stringer joint; our limit is four feet stringer rail joints must all break at least four feet, and them over another cross-tie. A carpenter cu stringer at the end of the rail for the joint chai above stated, is with us, eighteen inches long. I to adz the surface, so that it exactly fits the bo chair, and the latter bears its entire surface. H chair to project one-eighth of an inch above t so that when forced into the wood by the he street-car wheel, it will be level, as our chairs deep, unless they happen to come just over which should be the case about h [illegible] tim under the stringer, a [illegible] of

funds sufficient for each future renewal, and also a l
of $3,249.84.

The amount that will be saved in the track maint
I cannot figure, but it is safe to say that at least 50%
saved by the removal of articles which cause the rep:

The estimate for the Gibbon metallic system is f
upon his experience in laying the same.

Space does not permit an analysis of his estin
renewal.

The width of the street, and municipal legislation,
fix the distance between tracks, when double tracks a
With a gauge of 4 ft. 8½ inches, four feet between the
is a quite common allowance, but with present pra
building street cars, I prefer four and a half feet, as t
less danger of accident from passing cars.

When the street grade is level, I always incli
tracks towards the sewer-catch basin, one-tenth of a
each fifty lineal feet, to carry the water. It would b
difficult to maintain a pavement laid upon a dead
The pavement outside of the railway tracks requires
at each curb to convey the water to the sewer inlet; ar
an advantage to give an inclination in the same dir
along the railway tracks. Otherwise, the cross sect
the street will be so steep, next to the sewer inle
horses experience difficulty in maintaining a foothold

The gauge of the street railway is generally fi
law. Four feet eight and one-half inches is the most
In smaller towns, three feet is used. It possesses t
vantage that ordinary vehicles can not follow the rails
disadvantages; that if they run one wheel upon the r
pensive ruts soon wear into the pavement, and the
path is narrow for two horses of average size to
therein.

The following tables will prove useful in estin
quantities.

TABLE OF HOOK-HEADED RAILROAD SPIKES.—JONES & LAUGH
PITTSBURGH, PA.

Size measured under head.	Average No. per keg 150 lbs.	No. to lay one mile track four to a tie. Ties two feet from center to center.	Rail weigh lineal
Inches.		Lbs. Kegs.	
5½ x 9-16	280	5.670=38	45 t
5 x 9-16	300	5,170=35	40 t
4½ x ½	400	3 960=27	35 t
4 x ½	450	3 520=24	30 t
3½ x ½	510	3 110=21	
4½ x 7 16	510	3.110=21	28 t
4 x 7-16	630	2,560=17	
3½ x 7-16	675	2.350=16	20 t
3½ x ⅜	890	1,780=12	16 t
3 x ⅜	1,030	1,540=10 1-5	
2½ x ⅜	1,200	1,320= 8 4-5	12
2½ x 5-16	1,620	1.000= 6 1-2	8

NUMBER OF WROUGHT SPIKES TO KEG 150 POUNDS.—JONES & LA
LIN'S, PITTSBURGH, PA.

Length.	¼ inch.	5-16 inch.	⅜ inch.	7-16 inch.
3	2,250	-- --	---	---
3½	1,890	1,208	---	---
4	1,650	1,135	---	- -
4½	1,464	1,064	---	---
5	1.380	930	742	---
6	1,292	868	570	---
7	1,161	662	482	445
8	-- --	635	455	384
9	-- --	573	424	300
10	-- --	-- --	391	270
11	-- --	-- --	---	249
12	-- --	-- --	---	236

or linate
n B to D
The lengt
a rail of
. F. five fe
15½ inch

LS 20 FEET LO

Radius in f	Mi d

Within my own experience, new pine block paving required repairs within six months after it was laid in the horse paths, ruts being worn into the blocks adjacent to the rails. At the expiration of eleven months an inch and a half had been worn off the surface and the entire pavement had to be replaced.

Asphalt is not used in horse paths as the surface is very slippery and dangerous, except in exceptionally dry or wet weather. Square stones 3 or 4 inches wide, 8 to 12 inches long, 6 to 7 inches deep, are used, either of granite, sandstone, trap or other tough and durable rock. The Medina sandstone has given good satisfaction, so far as wear is concerned, in some streets, but will not endure the heavy traffic of a metropolitan line. In my tracks, ruts 1½ inches deep have worn in Medina sandstone next the rails, within twelve months and they had to be replaced by granite. The sandstone affords the horses a better foot hold than the latter, which is slippery at all times, but especially so when dry.

Col. Haywood found by observation that granite was most slippery when dry, safest when wet; asphalt was most slippery when damp, safest when dry; wood was most slippery when damp, safest when dry.

I have no hesitation in recommending cobble stones of suitable size and shape, closely set and thoroughly rammed into a bed of good cement gravel, as the best pavement in general for horse paths.

The stones should be hard, preferably of granite or quartzite, water washed, say six inches deep and four inches across the horse path, by three inches wide or kidney shaped, four or five inches at their largest diameter. The stones used by me, average about twelve square inches in the horse path, and a square yard weighed 495 lbs., the average weight of each stone being 4½ lbs.

My practice is to buy the stones by weight 13,000 to 15,000 lbs. making a cord, owing to the quality of the stone. Chicago obtains the best from the Lake Superior beach. Sample sizes and shapes are furnished to pick by. They are brought in sailing vessels and are inspected at the dock. All oversized or undersized stones are rejected or bought at a less price. The balance are weighed. The price varies according to the demand and supply, from $16 to $30 per cord on the dock. Before the stones are put in the track, they are again carefully sorted. It was my practice, to lay a granite block adjacent to each rail in the horse path, al- ternate blocks [illegible] a couple of inches to afford a bond with the [illegible] stones. The theory was that [illegible] wear [illegible] teams [illegible]. However, [illegible] has caused me to doubt the wisdom of this [illegible] for the following reasons: The granite [illegible] an average bearing surface of twenty-eight square inches. The cobble stone about twelve square inches. [illegible]

[illegible]

[illegible] stones [illegible]

[illegible] a summer [illegible]

[illegible] until [illegible]

[illegible]

When [illegible]

[illegible]

a short [illegible]

band, and driven full of spikes. A good weight for cobble stone rammers is 50 lbs. or about $\frac{8}{10}$ of a pound per square inch of surface.

For square stone paving the face of the rammer is made smaller.

No pine paving was laid in the city of Chicago during the year 1885. Cedar block paving, laid on pine plank two inches thick, over a layer of lake sand one inch thick, cost the city from 97 cents to $1.24 per square yard, and granite paving upon a concrete bed six inches thick averaged $4.00 per square yard during the same time.

Mr. A. G. Clarke, vice-president of the Cincinnati Consolidated Ry. sent a circular to various street railroads, asking an expression of opinion as to the best pavement for horse railroad tracks. He received replies from twenty roads, of which he states:

"With regard to the answers I received, I would say in brief that they were twenty in number, seventeen of which advised with very good reasons the use of cobble stones, as follows:

Boston, Mass., C. A. Richards, Pres. Metropolitan Ry.
Boston, Mass., James E. Rugg, Supt. Highland Ry.
Brooklyn, N. Y., Wm. H. Hazard, Pres. Brooklyn City Ry.
Brooklyn, N. Y., Wm. J. Richardson, Secy. Atlantic Av. Ry.
Buffalo, N. Y , H. M. Watson, Pres. Buffalo St. Ry.
Chicago, Ill., Aug. W. Wright, Supt. T. & C. N. Chicago Ry.
Chicago, Ill., James K. Lake Supt. West Div. Ry.
Cleveland, Ohio, H. A. Everett, Secy. East Cleveland Ry.
Columbus, Ohio, A. D. Rogers, Pres. Col. Con. Ry.
Louisville, Ky., H. H. Littell, Supt. L. City Ry.
New York City, Wm. White, Pres. D. D., E B. & B. Ry.
Philadelphia, Pa., Thos.W. Ackley, Pres. 13 & 15 St.Pass. Ry.
Pittsburg, Pa., John G. Holmes, Pres. Citizens Ry.
Providence, R. I., D. F. Longstreet, Vice-Pres. Union Ry.
Rochester, N. Y., P. Barry, Pres. R. City & B. Ry.
Springfield, Mass., F. E. King, Supt. S. Street Ry.
Toledo, Ohio, A. E. Long, Sec. Tol. Consolidated Street Ry.
Washington, D. C., H. Hart, Pres. Wash. & Georgetown Ry.

I have given you above all the names of those who favor cobbble stones. There were four other answers.

New Orleans, La., J. A. Walker, Pres. N. O. City & Lake Ry. He favors wood, but gives no reason.

Indianapolis, Ind. [illegible] have
no granite [illegible]
Syracuse, N. Y. [illegible]
Troy, N. Y. [illegible]
like granite."

The city of New Orleans [illegible] would be impossible to maintain [illegible]. There is no doubt the [illegible] wood.

The following letter and answers [illegible] me by Mr. Henry Hurt, President of the Washington & Georgetown Railway.

Statements of Leading Street Railway [illegible]

Office of the Washington & Georgetown [illegible]
101 Pennsylvania avenue [illegible]
Dear Sir—What do you regard as the best [illegible] ing the tracks of street railroads?
Yours truly, [illegible] President.

ANSWERS.

Office of Citizens' Passenger Railroad Co., N. W. cor. Tenth
and Montgomery Av., [illegible] 18, 1876.
Dear Sir—In our judgment small cobble stones make the best pavements for street railway tracks. Yours, etc.,
George Williams, President.

Office of the Second and Third St. Passenger Railway Co.,
2453 Frankford Road, Phil., April 18, 1876.
Dear Sir—There is nothing, in my opinion, that will equal cobble stone of small size laid in a good bed of gravel. We prefer them to any other material. Yours truly, Alexander M. Fox, President.

Hestonville, Mantua & Fairmount Passenger Railroad Co.,
4300 Lancaster Av., Phila., April 19, 1876.
Dear Sir—In answer to your letter of the 17th inst., we would say that cobble stones are considered the most durable for use between the tracks and better for the horse than Belgium blocks.
Very respectfully, A. Boyd, President.

Office 17th and 19th Sts. Passenger Railway [illegible]
Nineteenth and Master [illegible]
Dear Sir—Yours of the 17th [illegible] sider the cobble stones properly paved [illegible] tracks of street railroads. [illegible]

Office West Philadelphia Passenger Railway [illegible]
N. W. cor. [illegible]
Dear Sir—We have [illegible]

has been invented, and find the best of all is
down and covered with gravel. Yours, etc.,
M. S. K

Office of the Grand St. Railroad Co., New
Dear Sir—Small cobble stones such as
railroad in this city

Office of Wil
Street Railway Constructor, Philadel
Dear Sir—In reply to your inquiry, I will
best to pave the tracks of horse railroads with
six inches long, and set endwise, with a row of
side of each rail about six inches wide.
V

Office of John S
47 E. 27th St., New Yo
Dear Sir—Yours of yesterday at hand with
paving track of railroads. There is nothing bett
small size, about four inches in diameter, the sh
wise.
J

The foregoing opinions are those of
enced men, from various widely scatter
vast country, from the Atlantic to the P
founded upon personal observation and are
consideration. Both theory and practice,
differ widely, unite in this instance an
"selected cobble stones" *afford the best p
railroads.*"

cleaned rail. 2nd. Throwing up a ridge, adjacent to each rail along its outside line. Many think that in winter weather, passengers alighting from the car are liable to slip and fall upon these ridges, resulting in accidents. A prominent superintendent who had carried probably over a hundred million passengers, upon cars equipped with scrapers, told me he had yet to hear of an accident attributable to this cause.

SNOW PLOUGHS.

Snow-ploughs are built of various shapes and different designs, according to the locality where they are to be used and the consequent amount of snow to be removed.

Day, of Detroit, makes one, mounted upon a wagon so that it can be used along the Street Railroad track, or entirely outside. In excessive snow falls, this is an advantage, for at such times, the snow having been thrown up in ridges adjacent to the tracks, vehicles cannot either turn out or proceed along the street except upon the track, thus impeding street car travel. With such a snow plough as Day's, however, the banks on each side can be leveled outside of the tracks, when traffic will soon condense them and thus afford a passageway, removed from the rails.

Figure No. 38 shows a type of snow-plough used by the North Chicago City Ry. The frame is 6 feet 1 inch wide and 12 feet, 4 inches long of seasoned white oak and thoroughly braced. The floor is 38 inches above the track. Sills are 8 inches deep by 4 inches wide. The wooden dash at each end is 31 inches high and 73 inches wide, wheels are 30 inches in diameter.

It has eight knives of plough steel, one in front of each wheel, the plough running with either end front. Their bottoms are made to correspond in shape, to the rail head, and each is raised or lowered by a lever, as shown in drawing.

The plough proper, or scraper, is made of white oak 12 inches x 2⅝ inches x 10 feet 4 inches long, shod with iron. There are two of these scrapers, inclined at an angle of 18 inches in 24 with the line of track, passing on each side of alternate wheels. They are braced one against the other by two oak pieces 10 inches by 2⅝ inches wide, held together with ⅝ round iron rods. At the ends, additional iron braces are provided, as shown in drawing

boiler iron, well braced, and curved to graceful proportions similar to a "cutter." An iron ladder is provided on each side to mount upon the platform, which is 3 feet 10 inches above the track grade. The wheels are 30 inches in diameter. Axles 3¼ inches diameter with journals 2⅜x5 inches. Near one end of the axle a strong bevel gear is keyed, and motion is transmitted from it to the brooms by a pinion proportioned two to one. This pinion is hung in a square shaft with bearings running in a frame bolted to the oak framing. Arrangements are provided so that the pinion remains in mesh with the gear whether the frame be raised or lowered. A toggle joint permits irregular motion of either broom or pinion. The outer end of the broom shaft is carried by an improved journal box which can slide up and down on a vertical shaft shown on the side of the car. It is operated by means of levers, coupled together at the center, so that both ends of the brooms are lifted to the same extent and at the same time, causing equal wear. The broom when new can be lifted several inches clear of the track and depressed until only six inches of the rattan is left.

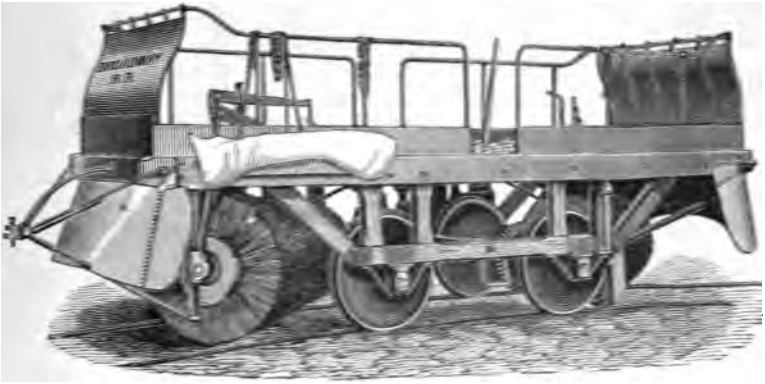
The brooms are made of white oak; four pieces are cut to a bevel and then turned to an outside diameter of nine inches. They are retained in position by hoops of iron, and are drilled to receive twenty-four rows of rattan canes, which are bent in at one hole and out at the next. They are held tightly in place by a filling. When new the outside diameter of the rattan is 38 inches. The brooms rotate in opposite directions. As before mentioned they are geared two to one so that if the horses proceed at a velocity of six miles per hour the broom rotates at twelve miles per hour. The speed at which they revolve throws gravel, snow or mud outwards with considerable force and it has been found necessary to enclose the sweepers with stout canvas curtains. One broom would not clean both rails, so two brooms at an angle of 45 degrees are provided, and a leveling broom is also placed outside at each end.

The smaller sized sweeper is estimated to weigh about two and a quarter tons, but the actual weight has not been taken of either sweeper, owing to the difficulty of getting them upon scales. The price of either size is about $1,000 delivered in any city; but this price may be reduced in the future.

The wheels should have deep and strong flanges and run upon them, for the snow reduces the adhesion between the head of rail and tread of wheel, so that the latter will slide before the brooms will revolve, should the bearing be taken between the wheel tread and rail head.

I use eight horses for the small sweeper and ten for the large sweeper, with four men.

Fig. [illegible] shows the sweeper manufactured by F. H. Clooney, of New York.



[illegible]

The advantages they possess over sweeping the tracks by hand are as follows:

1st. Cheapness. The cost of sweeping a track with such a machine I have found [illegible] 25 per cent. of the cost [illegible] hand [illegible]

2d. The tracks can be [illegible] of the time required for hand [illegible] secured to [illegible]

This is a decided [illegible] lars and cents [illegible] accommodate [illegible]

On [illegible] is more [illegible] The [illegible] time [illegible] care [illegible]

CHAPTER IV.

EQUIPMENT.

BUILDING OF CARS.

From time to time the officials managing street railways are required to consider the matter of erecting shops in which to build their own cars, and I have been frequently asked, " Do you think it advantageous for a Street Railway Company to build its own cars?" My answer has always been in the negative, founded upon the following reasons.

A Street Railway Company is organized to transport passengers, and the more nearly it confines its efforts to this purpose, the better.

Mr. M. Kirkman wrote: "In the operation of railroads, the objective point of endeavor is the revenue that accrues from the business transacted. It is for this that the proprietors contribute money for the construction of railroads; it is for this that they are operated."

Macaulay recognized this fact when he wrote: " Now, reasoning from analogy, we should say that these great corporations would, like all other associations, be likely to attain their end most perfectly if that end were kept singly in view."

It will be conceded that railways are not organized as manufacturers, yet in Illinois one-fifth of the total number of employees are shopmen and machinists upon the steam roads.

My friend Wm.K. Ackerman, ex-President of the "Illinois Central," operating over 2000 miles of road, contributed a most valuable paper to the *North American Review*, Dec., 1884, the result of his many years' experience and observation in divers positions, having been auditor, treasurer, president, etc., upon steam railways. Regarding the subject now under consideration, he wrote as follows :

" The establishment and maintenance of large and expensive manufacturing works by railway companies is, I believe, likely to be discontinued. Railway companies were not organized for the purpose of manufacturing, but for the special object of transporting merchandise and passengers. This is their particular business, and to this end the efforts of their managers should be specially directed. A manager charged with the care and responsibility of a railway cannot afford to have his attention diverted from his legitimate vocation; he has in fact little or no time to give to the supervision of a manufactory. In the early history of railways, before large and reliable establishments for manufacturing railway equipments and supplies existed, there was doubtless a necessity for each company to control its own manufactures in order to ensure thorough workmanship and proper materials; but with the facilities now offered throughout the United States by organizations, incorporated for the express purpose of furnishing the railway companies with rolling stock and other supplies, there seems to be no longer any necessity for the railways to maintain such extensive shops. Smaller shops, with largely reduced forces, are all that would seem to be required for ordinary repairs. Before the war of the Rebellion, almost every sugar planter in the South considered it necessary to maintain a mill on his plantation to grind his own cane. It would have been as reasonable to expect that every farmer in the North should have his own grist-mill to grind his grain [illegible]

"At present in the South, under the new order of things, one sugar mill accommodates several planters, and so in regard to the railways; even one repair shop, centrally located, might be made to answer the requirements of two or three lines, and in this way [illegible] system, the cost of even running repairs could be reduced to a minimum. But as regards new work there can be no question that it can be done more [illegible] with greater facility, and at less cost, outside of the [illegible] car shops. I know this does not harmonize with the views entertained by the master mechanics and master car builders; it is quite natural [illegible] the question of leas[illegible] the interest of the shareholders [illegible] will be consulted. The [illegible] ploying some [illegible] materially their working [illegible] labors and anxieties [illegible] of the entire force [illegible] engaged in manufacturing [illegible] they labor under great [illegible] great inconvenience [illegible] this force, and [illegible]

It is well nigh impossible for the master mechanic to keep an *accurate account* of the cost of constructing a car.

In building a locomotive one of the leading firms require a list to be filled out under 429 *heads*.

The Car Builders' Dictionary illustrates 136 parts entering into the construction of a street car. In an accurate account this would be doubled by labor, etc. Does any street railway company keep such an account? Without it they do not and can not know the cost of car construction. The balance is all charged to the repair account. This causes the master mechanic to neglect repairs upon the cars running on the road, to keep shop expenses as low as possible.

In his report to the president or superintendent he gives the total running expenses of the shop, ignoring taxes, insurance and interest on the investment. He credits this account with the construction of a certain number of new cars, charged at a price less than the amount asked by car manufacturers for a similar car. The balance is charged to the repair account, and divided among those cars that may have passed through his shop. There is no check upon this account, for what general officer knows how much his repair account would have been without any new contruction? He can not compare the expense of repairs per car with another company's account without personally examining the condition of each car upon both roads. The one road, without building new cars, may have expended more on repairs per car. This will, of course, show in the condition of its rolling stock, but bare figures will fail to indicate this difference.

The only real saving is in the matter of freight, if the manufacturer is not located in the same place.

I speak from experience when I affirm that as good cars in each and every respect can be purchased from the manufacturer as are or can be made by any street railway company in its own shops.

As a rule, it is best to maintain repair shops, and as work therein is apt to vary from time to time in amount, it is no doubt the part of wisdom for a company to build for its own use "open cars" when such are used (their construction is more simple, less complicated than that of "close cars") to retain its skilled labor and give it employment, when otherwise the men would have to be laid off, and might make other engagements; but one or two such cars would probably bridge over the slack times of twelve months. I might enlarge upon this subject *ad infinitum.* It is a matter of great importance to street railway companies, and to such as have not built cars I would say, consider well before entering into active competition with the manufacturer

CARS.

Fig. No. 42 shows the first car built for a street railway. It was modeled after stage coaches, a construction also followed in building the first passenger cars for steam railroads. This car was named "John Mason," in honor of the

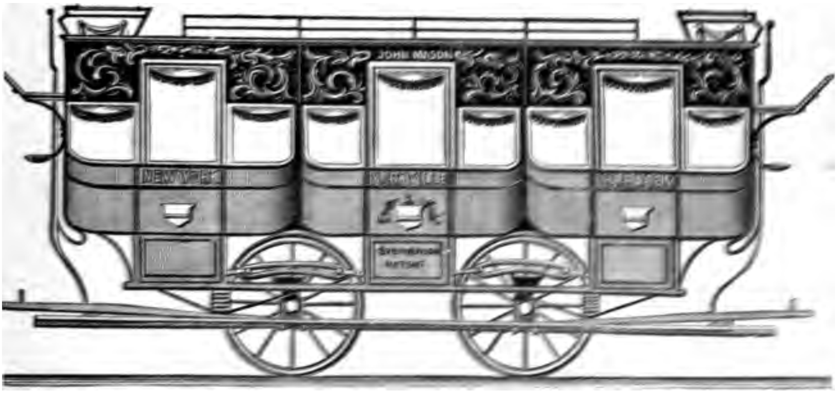


FIG. 42.

then president of the New York and Harlem R.R., which was operated within the city limits of New York by horse power, and was the first street railroad. It was opened in 1832. The next street railroad was not built until twenty years had elapsed. It was [illegible] Avenue [illegible] New York. John Stephenson built the "John Mason" [illegible] 1831, over half a century ago, [illegible] head a great business with the accumulated wealth [illegible] experience gathered during fifty-five years.

In Brown's interesting [illegible] motives in America" [illegible] street railway accident [illegible] course, upon the first street [illegible] The [illegible]

'John Mason' was a well known knight of the whip, Lank O'Dell, who always drove a pair of gray horses. The first trial, or experimental trip, was a most important affair in New York. The road commenced about Prince street and the Bowery, and extended to Harlem Bridge. On this occasion the streets along the route were crowded with spectators. Two cars were ready for the occasion, Lank and his grays taking the lead, with the beautiful pioneer car, 'John Mason,' and occupied by the Mayor and members of the City Council, while the second car, driven by a hack-man (his name not now remembered) and filled with some of the city officials and invited guests, brought up the rear. Great apprehensions were expressed by some of the passengers and many of the spectators, that the trouble would be in bringing these cars to a standstill at any desired point to avoid any accident that might occur in the crowded thoroughfares of the city.

"An old citizen, who witnessed this first experimental trip, related an incident that occurred on the occasion, which, though it resulted in nothing serious or fatal in its consequences, must have been ludicrous in the extreme.

"The vice president of the road, Mr. John Lozier, being very desirous of removing all apprehensions from the minds of the doubtful, and anxious to exhibit the great facility with which the cars could be brought to a dead halt in an instant, when running at full speed, and all danger of collision with vehicles in the street rendered impossible, determined on an experiment.

"He posted O'Dell and the hack-driver of the second car to watch him, and look out for the signal, and, inviting a number of spectators to witness the experiment, he placed himself somewhere about the corner of the Bowery and Third street. As the first car approached, he raised his arm and gave the signal to stop. O'Dell, who with his grays, had some previous practice while hauling materials in the construction of the road, performed to the admiration of the spectators, and had just come to a halt when the second car approached rapidly. The vice-president gave the signal to stop, but the hack-man, unpractised in the duty, forgot the lever (the brake), but drew hard his lines and shouted 'Whoa,' but too late—the tongue of his car went crashing through the rear of the 'John Mason,' and the Mayor and City Council beat a retreat in double quick time and [illegible] short time.

This [illegible] subject of [illegible] a source of great [illegible] when some [illegible] afterward [illegible] position and [illegible] him [illegible]

[illegible] time [illegible] of the amount of [illegible] sults that [illegible] dollars now invested [illegible] countries [illegible] beneficial effect [illegible] ests, the [illegible] convenience [illegible]

In purchasing [illegible] farm near [illegible] The cost [illegible] foregoing reason.

Street railway traffic [illegible] frequency with which car has [illegible] the patron starts [illegible] progressed so far [illegible] takes him. Excepting [illegible] traffic is heavy [illegible] the same running [illegible] double the number of [illegible] its patrons resulting [illegible] venience to the public.

John Stephenson [illegible] ence of half a century [illegible] *Railroad Journal.*

"No. 47 East 27th St. [illegible]

[illegible] *66*

"GENTLEMEN:—V[illegible] *Railroad Journal*, illustrating [illegible] small tram cars. You say the popular prejudice is strong against them 'every where.'

"The best statistics and sources of information accessible to us shows that in the United States and Canada there are about [illegible] tramways, of which Canada has about a dozen. Of these [illegible] roads, [illegible] are operated with small ('bob-tail') cars, and [illegible] are operated with large (conductor) cars. A reference to our order book for the year 1882 showed that two-thirds of our orders were for small cars. The small car system is a boon to the public, because: (1). Tramways accommodate the public when otherwise they could not exist. (2). The accommodation is better, because usually three small cars are used successfully when the effort to sustain two has proved a failure; (3). Economy of time equal to fifteen to twenty per cent., because the small cars make fewer stoppages and being lighter, are stopped and started more quickly; and (4). Merciful to horses. [illegible] In the bob-tail car the one horse easily does the work, with better footing in the track."

The chief objection heretofore urged by the public against the use of the 'bob-tail' car has been the trouble of depositing the fare in a box at the forward end of the car, [illegible] in a fare conveyor. Mr. Small has [illegible] the passenger is provided with the [illegible]. He or she can then place the [illegible] conveyor with as little trouble as [illegible] without getting a seat. The [illegible] small tubes fastened to each [illegible] from the rear platform into a [illegible] car. The top of the tube [illegible] angle. It is inclined from [illegible] money or a ticket of [illegible] material, acted upon by [illegible]

[illegible] the passenger had [illegible] car and deposit the [illegible] to pass it forward, [illegible] inconvenience.

[illegible] especially for ladies, to [illegible] moving car. Frequently [illegible] the effort, result- [illegible] While the passenger was taking his fare to the box some one else would frequently take his seat. All this is a thing of the past.

The advantages offered by the use of a small car, without conductor, have been clearly set forth by Mr. Stephenson. The daily saving to the street railway company is considerable, and may be approximated as follows:

DAILY ESTIMATED COST OF RUNNING 18 HOURS.

One-horse Car.		*Two-horse Car.*	
5 horses @ 50c	$2.50	10 horses @ 50c	$5.00
1½ driver @ $1.75	2.62½	1½ driver @ $1.75	2.62½
		1½ conductor @ $1.75	2.62½
	$5.12½		$10.25

Showing an economy of 50 per cent. in daily operation. If the same number of cars are run, there is a further saving in the interest on the amount of capital invested in the larger and more expensive car, and the additional horses, stable, etc.

The use of the fare-box offers an additional advantage, inasmuch as the receipts are not handled by the driver or conductor, and less opportunity exists for peculation.

The majority of street railways, therefore, find it largely to their pecuniary interest to use " bob-tail " cars until their traffic increases to a point demanding a larger car, in their opinion. My own notion is, that many roads now running large cars, would have found it advantageous to run " bob-tail " cars, but having once used the large car and conductor, they can not change. The public demand, day by day, more and more from the street railway companies. Whether or not the company may be returning a fair profit on the capital invested, is the least of its consideration.

When the climate is so severe as in our northern latitude, and the cars are unheated, the door should be opened as little as possible, and some means should be provided by which streets could be announced by the conductor without opening the door. A slide in the door, or speaking tube, or something of the kind, would serve a useful purpose.

As the box car is not usually used in summer, it should have a closed back, without perforations. Owing to the difficulty of cleaning upholstered seats. I am incline
the use of a carpet, extending up to the top of t
the seat and down in front. It can be readily re
cleaned so often as may be necessary. The sp

"Galled necks of horses is not the result of the point of draft on our cars. Poles will do this. The weight of the collar and traces, and chafing of harness, are common causes; for in the trotting wagon, with the traces horizontal, the necks of horses chafe, and the 'Dutch collar' is substituted to relieve the horse's neck.

"Spring drawheads are of vital importance in operating horse cars, and are a great relief in starting, as also at each step of the horse. A pair of horses, of a ton or more weight, put in motion, will give an impulse in starting the car, though the muscular energy of the animal should be for the moment passive; but when the two co-operate, the car is started with less strain to the animal, and furthermore, a spirited horse, finding his load coming, takes courage to continue his effort, which he would not do if the load was unyielding. Therefore the elevated drawhead is to be deprecated, because it prevents the use of a spring drawhead.

"VARIOUS NOTIONS.

"To humor our customers, we have made between 50 and 60 different styles of drawheads, of which we now have patterns. Which is.

BEST

"We have solved by deductions from scientific study and practical experience of 55 years, and, when left unembarrassed, we give to our customers this 'BEST:'

"No one can be more interested than ourselves in having the BEST, as that is our motto.

"We are careful students of advanced science, and the developments of experience, in both of which we have aggregated as no other has had the opportunity, and our interest is manifest by this correspondence."

Considering this letter in detail:

"1st. Every 15.6 pounds *lifted* by the horse suffices to keep 2000 lbs. in motion!" As to bad joints; I went out on our track at random upon the receipt of this letter, and examined forty points where our cars stop. In Chicago, to make better time and save horse flesh, the street cars stop only at street intersections, or in the middle of blocks over 500 feet in length. The stopping place in the latter case is marked by a sign "Cars Stop Here."

I found if the car was stopped, as it should be, with the rear platform opposite the cross-walk in the street, that

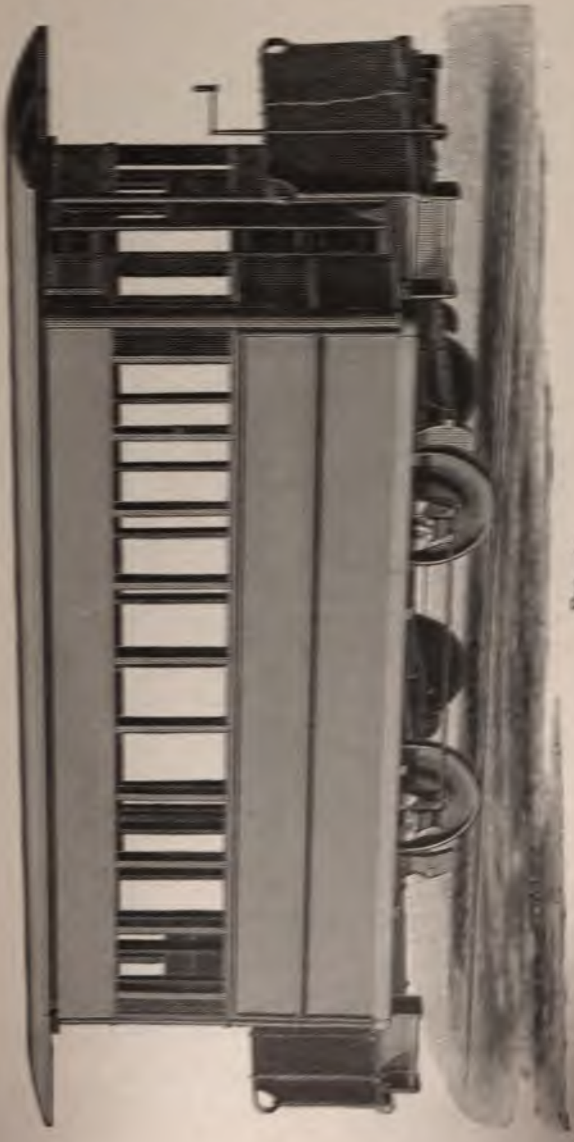


FIG. 44.

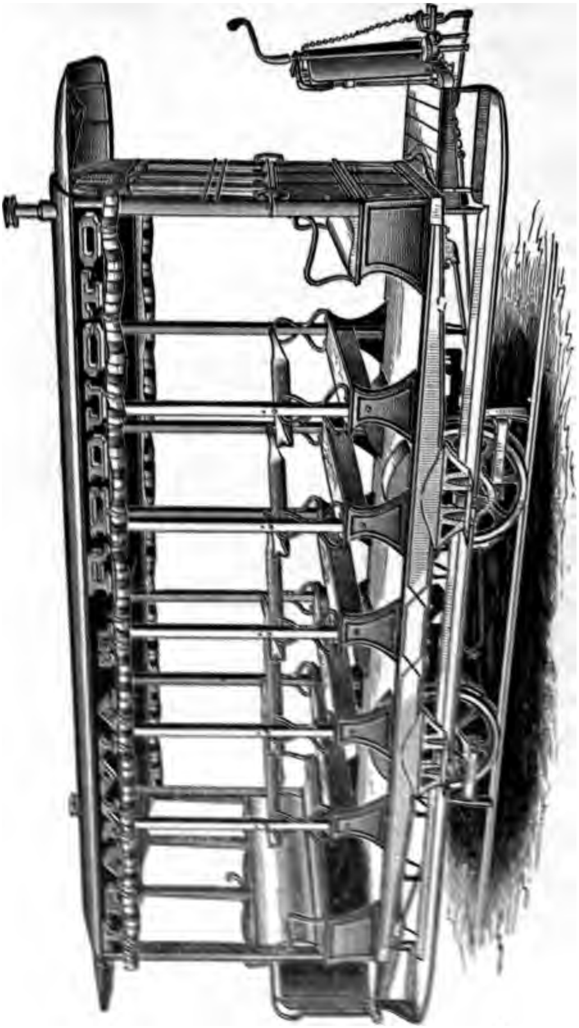


FIG. 49.

platform were not so much in the way. After many years' use, I think the elevated drawbar without a spring preferable to the "Best" at the door with -

We have about as severe grades as are anywhere surmounted by cars with horses, to-wit: 24 ft. 7 in. in 2200 ft. =1 ft. in 90 feet; 37 ft. 1 in. in 1404 ft. =1 ft. in 40 feet; 31 ft. 9 in. in 2239 ft.=1 ft. in 70 feet. Our one-horse bars are 28 inches from rails. Our two-horse bars are 30 inches from rails, when the elevated bars are used. On one line only we use the bar from bottom of platform 22 inches high. On open cars, 24 inches and 26 inches; length of traces about as in your article.

We only operate 15 open cars in summer. While these each seat 40 persons, I can not admit that the horses doing this work fare worse than those on box cars for the same period. And looking over our horse account I find we average, for past seven years, 1,067 horses; and the renewal of the same

[illegible]

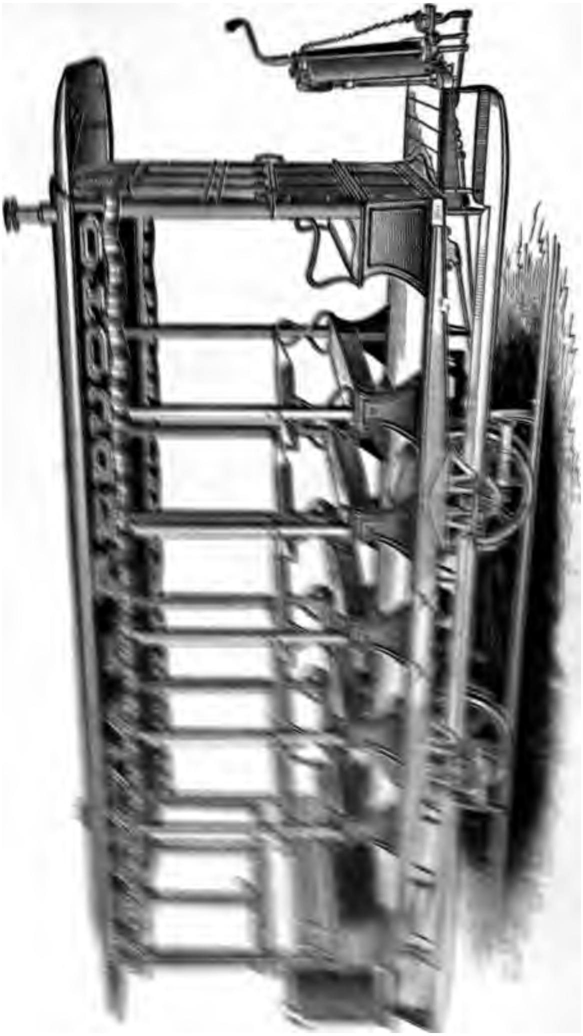


FIG. 49.

We have about as severe grades [illegible] mounted by cars with horses [illegible] =1 ft. in 90 feet ; 37 ft. 1 in. in [illegible] ft. 9 in. in 2239 ft.=1 ft. in 70 feet. [illegible] are 28 inches from rails. Our two-horse [illegible] from rails, when the elevated bars are used. [illegible] only we use the bar from bottom of platform [illegible] high. On open cars, 24 inches and [illegible] traces about as in your article.

We only operate 15 open cars in summer. [illegible] seat 40 persons, I can not admit that the horses [illegible] work fare worse than those on box cars for the same [illegible] And looking over our horse account I find we average [illegible] past seven years, 1,067 horses ; and the renewal of the [illegible]

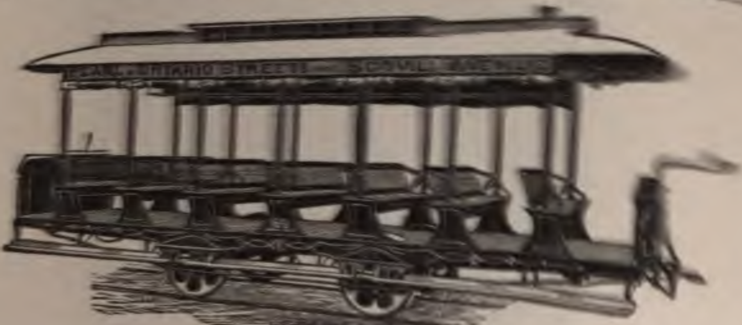


FIG. 50.

to average 18.87 per cent. per annum. This I think will compare favorably with any similar table of work from draw-bar at floor level of cars.

I notice, of late, Stephenson places his on top of the bumper, which accounts for the three inch rise.

Yours respectfully, W. WHITE.

RUNNING GEAR.

This is also an important matter, and worthy of careful consideration. A poor gear and bad springs add to the burden upon the horses propelling the car, to the expense of maintenance and to the discomfort of passengers.

Each superintendent has decided for himself which of the gears now prominent in the market he prefers, and [illegible]

CHAPTER V.

BUILDINGS FOR STREET RAILWAYS.

This subject will be considered under the following heads: Stables and Car houses.

STABLES.

The horse railroad companies in the United States employ nearly a hundred thousand horses and mules. No other lines of business aggregate such large numbers under the supervision of so few men. Anything affecting the health of these horses is a matter of prime importance to the various owners, and the construction of the stables in which the car horse passes so many hours should receive the careful consideration its importance, measured in dollars, demands. Permit me to quote from a report that I made to the American Street-Railway Association on "Buildings":

"We appeal to you in behalf of the horse, to give him suitable stable quarters; but this we urge upon the score of economy, rather than humanity. No other line of business employs as many horses in the cities and towns of this country, under one management, as the one we represent, namely, horse railroads. About 30% (to 40%) of our operating expenses is expended in the horse department, amounting in the aggregate to a vast sum of money. Anything that will reduce this expenditure, by prolonging the life of the horse, which is now about four years, more or less, is worthy of investigation. Badly constructed stables are responsible for many, very many, of the diseases among horses. The paramount importance of abundant sunlight, perfect sewerage and good ventilation is now, fortunately, recognized almost universally in building human habitations, but how often ignored in providing quarters for the horse, the number sick and unfit for duty, most eloquently testifies. John Stewart wrote, 'Stables have been in use for several hundred years. It might be expected that the experience of so many generations would have made them perfect. They are better than they were some years since. * * * A damp stable produces more evil than a damp house. * * *

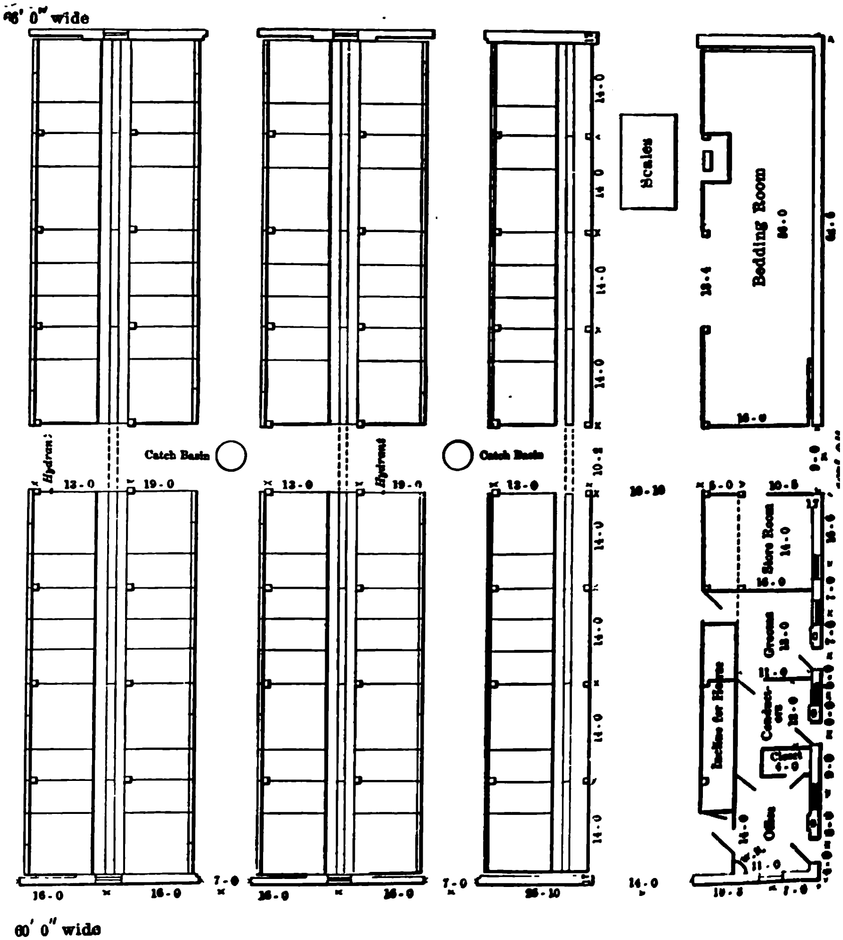
The horses face north and south, and in the rear of each row, an alley 10 feet wide extends entirely across the stable, with a sliding sash door at each end 7′x10′. Another alley 9′ 6″ wide, extends the entire length of the stable at right angles to the first described alleys, with large, sliding sash doors at each end.

The stalls are 9 ft. deep, and each horse is allowed 56 inches of width. Double stalls are, in my opinion preferable, when horses will stand together quietly, but the service of horses on street railways is so comparatively brief, that many teams will not stand quietly together in double stalls and I therefore alternated a double stall, with two single stalls, thus permitting the foreman to place the horses who do not agree with each other, in single stalls.

The floor of this stable consists of 4 inches of asphalt, having scantlings embedded therein 2″x4″, placed on sixteen inch centres, to which a pine floor is spiked. The latter consists of boards surfaced one side, and put in the hot asphalt, which fills every joint and is water tight. A flooring of two inch common plank is placed on top in the stalls, to take the wear. The stalls incline two inches from their head to a gutter in the rear, which connects with a catch basin through suitable traps. These gutters are covered by cast iron plates six inches wide, fifty-six inches long, perforated to allow the urine to pass into the gutter. These covers are movable, and at least once each week they are all taken up and thoroughly cleansed by scraping and washing, in addition to which some disinfectant should be used.

Between each row of horses there is a "feed-alley" four feet wide. By this construction the horses are not brought head to head, to breathe each the other's breath, contaminated perchance by disease, which is thus spread from one to another. Food is not wasted in placing it in the manger, for it is taken directly from a feed cart in the alley in front of each animal. There is less danger of an employee being injured, or perchance crippled for life, in entering the stall to feed some vicious or frightened horse.

At each end of these feed-alleys windows are placed, containing 32 lights of glass 9″x14″, a size I adopted as a standard, and used whenever possible to avoid carrying a stock of various sizes. In these feed-alleys, bene
floor, there are placed fresh air ducts extending cle
the stable, from outside to outside, through which



CHICAGO CITY RAILWAY STA.

FIRST STORY FLOORS.

The entire first story will be covered with common pine boards, surfaced one side, and bedded in hot asphalt and well nailed to joists. Upon this, in all alleys, there will be a wearing floor of common pine, 3" thick. Posts carrying second story will be 10x10, surfaced four sides, and corners chamfered, of good and sound pine lumber, sawed square, all to have good and true bearings on plinths, and set plumb and true.

Corbels 10"x12"x4'—0", dressed four sides and cut to pattern, and well spiked to posts.

Cordties dressed one side to 1⅞", and depth corresponding to girder. Girders 4"x14"—6"x14"—6"x16," as shown on drawings. To be sized of equal hight over corbels, to true and level bearing. To be well bolted, as shown on plans, and nailed to corbels. Spans over 16 feet to be packed and bolted.

SECOND STORY.

Joists to be 2"x12," laid 16" centers, all to be of equal depth on bearings and bridged each 8'—0' of length, with 1½"x3", cut to fit, and well nailed with 10d nails. Frame all necessary headers and trimmers around chimneys and ventilators, and wherever required.

Floor to be of dry, common fencing, dressed and matched, all loose or unsound knots to be cut out and floor laid close and well nailed with 8d nails.

Posts to be 6"x6" or 10"x10" as shown on plans. Cut in lengths to form roof pitch of ½" in 12"; corners chamfered and set plumb and true; corbels for same to be 10"x12", cut to pattern and securely nailed to posts.

Girders 3"x12"—6"x12"—6"x16", according to plan. Sized over corbels to level and uniform bearing.

Roof joists to be 2"x12", laid 16" centers, sized on bearings, well bridged, each 8'—0", lineal feet, with 1½"x3" stuff, securely nailed with 8d nails. To be covered with common boards, dressed one side to ⅞", all loose or unsound knots, shakes, or imperfections to be cut out, well nailed at each joist with 10d nails. Furnish and cut all wall plates 2"x4" for proper nailing of roof felt to brick walls.

VENTILATORS.

There will be —— ventilators. For construction see detailed drawings.

PARTITIONS.

Unless otherwise specified, partitions will be of 2" pine surfaced two sides, and joists covered with battens on one side, 2½" wide. Girts for same, 2"x6", dressed four sides.

Stall partitions will be of 2" common pine, surfaced two sides, to 1¾ and 3'—6" high, stood perpendicular, with lower end let into floor one inch, and upper end held by oak caps, cut to pattern, and each end of said cap securely fastened to posts with iron fastenings. Twenty-two inches above the top of this cap a girth of oak, 2"x4", dressed four sides, will be inserted to hold the iron partition rods in place between horses.

All double stalls will have swing bars of oak in two pieces, the lower, 2"x12"x5'—4", hung with iron screw rods, swivel joints, to the upper 2"x12"x8'—0." The latter will be hung to the manger at its front end, with a chain connection, and to the plates on top of stall posts at its rear end by ½" iron rod, with chain and wagon break attachment at its lower end, so that it can be readily detached and dropped to the floor.

Stall plates on top of posts will be of pine, 2"x6", doubled over all double stalls.

Stall posts will be of oak, 6"x6"x8'—0", dressed on four sides, and corners chamfered. All posts set plumb and true, and containing a harness pin, turned from oak or ash.

Feed alley partitions will consist of three pieces, 1"x10", common pine, surmounted by one piece, 2"x16", dressed one side.

DOORS.

Doors to be made in accordance with detail drawings. Carpenter to furnish lintels, 4"x8", dressed top and one side, for all doors and windows; also rails for all sliding doors and hung doors in most substantial and workmanlike manner.

WINDOWS.

All window frames and sash to be made according to details and set in accordance with plans, plumb and true.

MANGERS.

The mangers will be built of oak, top and front 2"×12", and thoroughly fastened and secured in plan.

DOOR SILLS.

Door sills, with exception of three stone sills, will be of oak four inches thick, sixteen inches wide, and six inches longer than opening in brick wall.

The following is an itemized bill of the lumber used in the construction of this stable.

			Inches.	Feet.	
	1280	pieces	2×4,	14	
First floor joists	160	"	2×4,	10	
First floor posts	112	"	10×10,	14	
First floor posts	2	"	10×12,	14	
First floor corbels	112	"	10×12,	4	
First floor corbels	2	"	10×12,	12	
Second story girders	128	"	4×14,	14	
Second story girders	80	"	6×14,	20	
Second story girders	28	"	6×14,	16	
Second story girders	4	"	4×14,	12	
Second story joists	177	"	2×10,	10	
Second story joists	1400	"	2×12,	14	
Second story posts	28	"	6×6,	7	
Second story posts	28	"	6×6,	8	
Second story posts	54	"	6×6,	9	
Second story posts	2	"	10×10,	9	
Second story corbels	110	"	10×12,	4	
Second story corbels	2	"	10×12,	12	
Roof girders	126	"	3×12,	14	
Roof girders	78	"	6×12,	20	
Roof girders	2	"	6×16,	30	
Roof joists	1400	"	2×10,	14	
Roof joists	177	"	2×10,	10	
Air ducts, sides	112	"	2×12,	14	
Air ducts, sides	14	"	2×12,	10	
Air ducts, tops	56	"	2×12,	14	
Air ducts, tops	14	"	2×12,	10	
Air ducts, bottom	56	"	2×10,	14	Dressed 2 edges
Air ducts, bottom	14	"	2×10,	10	
Gutters, sides	192	"	2×12,	14	
Gutters, bottoms	96	"	2×5,	14	Dressed 2 edges
Stall partitions	720	"	2×12,	14	Dressed 2 sides.
Partitions	400	"	2×12,	16	Dressed 2 sides.
Feed alley partitions	96	"	2×16,	14	
Feed alley partitions	288	"	1×10,	14	

			Inches.	Feet.	
Bridging	700	pieces	1½×3,	10	
Wall plates, etc.	140	"	2×4,	16	
Lintels, windows	25	"	4×8,	16	
Lintels, doors	20	"	4×6,	16	
Stall caps	220	"	2×6,	14	
Ventilators	36	"	4×4,	16	Dressed 4 sides.
Ventilators	100	"	1¼×1¾,	14	
Crown mouldings	35	"	3	14	
O. G. Battens	500	"	2½	16′	
Quarter round	400	"	1½	10	
Casing	100	"	1⅛	16	Dressed one side.
Cord ties	245	"	2×14,	4	Dressed one Side.
Cord ties	245	"	2×12,	4	Dressed one side.
Gutter strips	192	"	1×2,	14	
Door bars	16		3×6,	8	Dr'sed 4 sides 3rd clean.
Door bars	25	"	3×6,	16	Dr'sed 4 sides 3rd clean.
Door bars boxes	32	"	1×6,	16	Dr'sed 1 side 3rd clean.
First floor	2″×10′,		5000 pr	Bm.	
First floor	2″×9′,		37500 pr.	Bm.	
First floor	2″×16′,		16000 pr.	Bm.	
Second floor D & M C F	1″×16′,		30000 pr.	Bm.	
Second floor D & M C F	1″×16′,		40000 pr.	Bm.	
Roof C B S 1 side	1″×16′,		30000 pr.	Bm.	

Oak.

			Inches.	Feet.	
Stone posts	360	pieces	6×6,	8	Dressed to pattern.
Stone caps	216	"	2×4,	7	Dr'sed 4 sides
Stone caps	8	"	4×4,	8	Dressed to pattern.
Stone caps	240	"	4×5,	8	Dressed to pattern.
Stone mangers	216	"	2×12,	14	
Swing bars	72	"	2×10,	5⅓	
Swing bars	72	"	2×8,	9	
Door sills	16	"	4×16,	7½	
Door sills	2	"	4×16,	14	
Door sills	2	"	4×16,	10	

MILL WORK.

15 sash doors	3½″	double thick	7′ 3″×10′ 8″	Plan E.
3 doors	2½″	"	4′ 3″×8′ 0″	Plan
5 doors	2½″	"	4′ 0″×8′ 0″	Plan

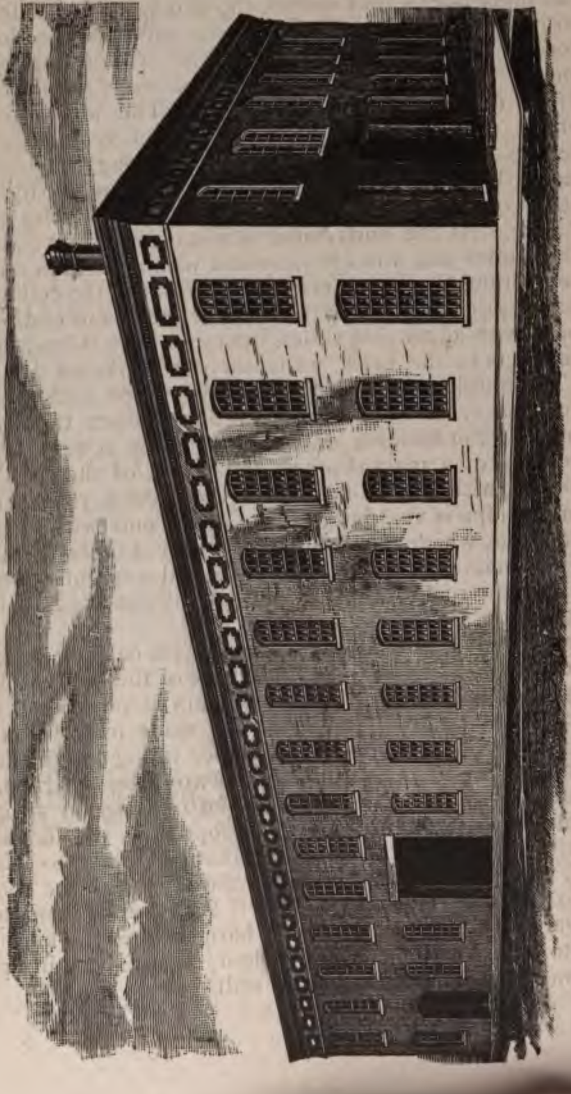


FIG. 64.

are built of two thicknesses—an outer one of eight inches and an inner one of four inches, the two being separated by a two-inch air-space. The air-space answers the double purpose of keeping the stable warm in winter and cool in summer. There are [illegible] rows of stalls separated at the front ends by a four-foot alley. The alleys are an important factor in the general scheme of ventilating the stables, as the fresh air is introduced through their floors. Underneath alley floor [illegible] a [illegible] made a air-tight a possible [illegible] with the stable by means of [illegible] the alley floor [illegible] with the [illegible] for [illegible] the stable [illegible]

[illegible]

will add not only to their general appearance but to their efficiency as well. A numbered badge should be worn at all times when on duty, and in a position to be plainly visible.

"They should treat each other with respect; be cautious and considerate, guarding themselves against envy, jealousy or other unfriendly feelings, refraining from all discreditable communications, except to those in authority, and upon such matters as it is made their duty to report. They should use no vulgar, profane, improper or ungentlemanly language, nor be guilty of any ungentlemanly conduct upon the car, to passengers or others, nor upon the company's premises. They should be civil, courteous, polite and attentive to the passengers at all times; be patient and answer any reasonable request of passengers, and direct strangers and others, when requested, to the nearest and safest way to their places of destination. They should abstain entirely from the use of intoxicating liquors, and should not frequent any place where the same are sold. They should not accept any fee, gift, treat, or entertainment of any kind from each other or from any employee of the company. They should attend punctually at the stable to take out their cars; remain with them at all times when *en route;* conform to the running time as nearly as possible, and always stop and start the car by the prescribed signal. The signal in most general use is one bell to stop, and two bells to start; and upon open cars it is customary and advisable to permit the use of a whistle for signals. The driver should signal the conductor by one bell for each passenger getting on at the front end after the first collection of fares. Other signals for putting on the rear brakes, for increasing speed, or to stop suddenly, are usually provided for, and will be found useful in an emergency. Every conductor should carry a watch, keep it exact with the office time, and start his car from each terminus promptly at the advertised time.

"The proper position for a conductor, when not otherwise engaged in the performance of his duties, is upon the rear platform, standing erect and on the watch for persons desiring to take the car. He should not engage his attention in reading, in unnecessary conversation with passengers, or in any way which would interfere with a correct and prompt performance of his duty.

"The driver should stand erect, with right hand on the brake-handle, controlling his horses with a taut rein, keeping a vigilant watch for persons who may desire to take the car, not only in the main, but in side streets, and at the same time with a careful eye to avoid collisions with pedestrains or vehicles, and should always speak pleasantly to teamsters when requesting them to move. They should both be ever on the alert to advance the company's interests and always ready to assist each other in any emergency. Cars, when heavily loaded, should not be stopped on steep grades, nor upon curves, except to avoid accidents. Jumping cars from the track should not, as a rule, be allowed ; on a single track it is better to change cars, or to run back to the nearest turnout.

"When necessary to eject a passenger for any cause, the aid of a police officer should be employed if possible. No more force than is absolutely necessary should at any time in such cases be used, and the names of reputable witnesses should be obtained. Suitable blanks should be furnished, to be filled out in case of accident, and upon which a full statement should be at once written and delivered promptly at the office. Articles found in the car should be promptly turned in at the office, with accompanying memorandum giving particulars.

"SAFETY, COMFORT AND CONVENIENCE TO THE PUBLIC.

"The conductor comes in more direct contact with the public than the driver, and while many rules are applicable to him, the driver should at all times co-operate with the conductor as far as he can in carrying out the rules in their spirit and intent.

"The car should be kept clean and the lamps trimmed at all times, but it will in most instances be found desirable to provide special labor for this purpose and not make it a part of the duty of the driver and the conductor. Special assistance should be given to ladies, children and elderly or
crippled persons getting in or out of a should
always be provided as far as possible. and
stormy weather the doors should be kep h as
possible. The rear platform should b of
passengers as possible, and children
allowed to ride upon either platform.
not be allowed to stand in the door
when it is possible to avoid it.
requested to alight at the rear en

fares at the front end and work to the rear. After fares have once been collected the driver should signal by one bell for every person getting upon the front platform, and all additional fares should be collected promptly as soon as passengers reach the place in the car to which they intend to go.

"Each fare should be registered at the exact place where it is taken, in the presence of the passenger paying it, and before another is collected. When fare-boxes are used the driver is also the conductor, and should not be permitted to handle the fares, but should see that every passenger's fare is deposited in the box.

"Having completed a set of rules to his satisfaction, no railroad manager should stop then; rules, no matter how good, will not enforce themselves, but the better the class of men employed, the easier it will be to enforce good rules.

"Drivers and conductors should be not only faithful but intelligent, for they are very often called upon to use discretion in matters which it is impossible to cover by the rules.

"As far as possible these employees should be selected from among the residents of the city or town in which the road is located, and such as are favorably known and indorsed by reputable citizens of the town. When first employed they should not be less than 21 or more than 40 years of age, energetic and of good habits. The pay should be sufficient to attract and hold such men, and their hours of labor should be fixed within the bounds of reason."

RULES AND REGULATIONS

FOR THE GOVERNMENT OF THE CONDUCTORS AND DRIVERS
OF THE NORTH CHICAGO STREET RAILROAD CO.

(*Adopted August* 1, 1886.)

DUTIES OF THE CONDUCTOR.

1. He is to be cleanly in his personal appearance, make use of no profane or improper language, and is to abstain from smoking, from the use of intoxicating drinks, and all ungentlemanly conduct or unnecessary conversation, w on duty or on the company's premises. He must not any saloon while on duty.

2. His position when on duty, and not collecting fares or seating passengers, will be on the rear platform. This position will the better enable him to keep a vigilant lookout for passengers in the opposite direction from that in which the car is moving on all corners and cross-streets. He will announce the names of principal streets as they are approached.

3. He will endeavor, as much as possible, to be on the rear platform when the car is passing street corners, especially those where he is likely to receive passsengers, and never to go inside of the car to collect fares as the car approaches a prominent cross-street, but immediately after the car has passed it. The car should be gently slackened as it approaches prominent cross-streets, to avoid collisions, and the better to enable the driver and conductor to see passengers upon them.

4. He is to stop the car in taking up and letting out passengers at the further crosswalk in going either way. He will endeavor to be on the rear platform, in all cases, when receiving or landing passengers, and not start his car until they are fairly received or landed; nor shall he allow elderly or infirm persons, ladies or children, to enter or leave the car while it is in motion, to get off or on the front platform. He will also, when passengers are getting off from the car, look and see that no car or team is approaching by which they might receive injury.

5. It is his general duty to provide seats for passengers as far as practicable, especially for ladies; and passengers [illegible] be allowed to stand upon the rear platform or steps when there are seats or standing room inside the car, as they obstruct the passage of those who wish to enter or leave [illegible] The conductor should politely ask them to take [illegible] inside of the car.

6. He will always strike the bell to stop the car whenever any passengers make it known that they wish to get off, notwithstanding [illegible] to the contrary. He is to render all needful assistance to passengers having children, parcels, etc., and especially to ladies and elderly persons. He will not allow any drunken, filthy or indecent person in or upon the car, nor permit any passenger to use any profane or indecent language, or be guilty of disorderly conduct; such persons should be ejected from the car, using no more force than is necessary. On no account, however, is a passenger

to be ejected while the car is in motion. In an ordinary case, or for a passenger refusing to pay fare, he is to call upon the nearest police officer. He is to be polite and courteous to all passengers under all circumstances. He is to be patient and answer any reasonable inquiry in reference to the road or company.

7. ACCIDENTS.—He will use the utmost care and caution to prevent accident of every kind to persons and property of the company. If any accident occurs, however slight, to persons or property, or to the property of the company, he must report the same as soon as possible to the superintendent or his assistant; also at the receiver's office for record; giving all the particulars and details, and as far as he is able, obtain the names and addresses of all witnesses to the accident. If persons are injured, however slightly, he must obtain their names and addresses in full, and render all assistance in his power.

8. He is to obey the driver's call—a tap of the bell—to collect fare from passengers on the front platform immediately, and pass on the outside of the car when it is crowded. He will render all needful assistance to the driver, which will be called for by a tap of the bell, when it may be necessary to hold the horses, or detach them from the car, and he is always to take the horses by the head when they are to be changed from one end of the car to the other.

9. He will not allow barrels, boxes, lumber, iron, or merchandise of a bulky nature to be put on the car; neither large dogs, nor baskets or bundles of meat inside the car; neither will he allow cards or showbills upon the cars without the permission of the superintendent or his assistant.

10. He is not to leave his car until he arrives at the end of his line, without permission of the superintendent or his assistant, nor to sit in his car when it is in motion, read the papers or any other matter that will interfere with the discharge of his duties.

11. He will report all defects in the road, cars, or horses, or any excavations at the side of the track, to the superintendent or at the receiver's office.

12. He must wear his badge at all times, when on duty, so that the number can be plainly seen by any one who may wish to know it.

13. He must be at the car house where the car is ke *that he is* to run, five minutes before the starting time.

must start promptly from the terminus of his route on card time, always keeping his watch exact with the clock at the receiving office.

14. All conductors, when appointed, are to serve as extras, in number according to their turn and time of appointment, as follows: When a regular conductor is discharged, No. 1 extra is entitled to his car, and the remaining extras are provided in their regular order. Should any conductor not be on hand as required by Rule No. 13, he will be placed at the bottom of the extra list, and extra No. 1, if in attendance, will be entitled to the car; if extra No. 1 is not there, the next extra who shall report himself is to take the car, and extra No. 1 is to be placed at the bottom of the list. He is to assist in taking his car from the car house in the morning and putting it up at night.

15. He must be in full uniform while on duty. He must call out streets going south from Chicago avenue and going north from Kinzie street.

16. He will obey the directions of the assistant superintendent concerning his duties at the car house.

17. When wishing to report for duty, he will report to the assistant superintendent before five o'clock P. M.

18. He must stop his car at the farther crossing of any street, and in the middle of long blocks where sign is placed, for any passenger who wishes to enter or leave the car.

19. He must not stop at the first crossing of any intersection, on the bridges, or up grades, except to avoid an accident.

20. He will not be allowed to leave his car at the bridges, or at the end of the line, except in the performance of his duty. Going north, he will commence collecting fares immediately after crossing Lake street.

21. When going south he will stand by the rear brake of his car when crossing the viaduct and the bridge, until reaching South Water street, so that in case of an accident he can put on the brake; also, when going north down the grade, when not collecting fares.

22. He will not allow his car to stop at the north end of the bridge, but must go to the viaduct.

23. He will not allow any person to sit on the front dashboard under any circumstances.

24. He will not be allowed to sit on the dashbo

APPENDIX I.

Amount of Horse Power Used in Propelling Street Cars.

A paper read before the Western Society of Engineers, Nov. 3, 1885.

By Augustine W. Wright.

At the present time great interest is manifested by street railway companies regarding the question of the substitution of some motive power to propel their cars other than horse flesh. The various systems—electrical, cable, compressed air, Honigman, steam dummies, etc., etc., are prominently before the public, and each for itself claims, if not perfection, certainly that it is better than any other system.

It appears to me that great ignorance exists upon the part of the inventors and street railway companies themselves, as to the amount of power required to start a street car and to maintain it in motion, under average conditions. Following is an attempt towards a solution of this problem:

We will begin with Horse Power. Watt's experiments, made with large horses of the London Brewers, gave 33,000 pounds raised one foot high in one minute as the power exerted by an average horse, and this, as you all know, is the allowance in figuring engine power. This is on the assumption that a horse can exert a force of 150 lbs. over 20 miles per diem at the rate of 220 feet per minute or 2½ miles per hour, during 8 hours. But the horse's power is very variable at different speeds. Tredgold's experiments gave 125 lbs., Smeaton 100 lbs., Hatchette 128 lbs.; all 20 miles per diem at 2½ miles per hour. Gayffier fixed the power of a strong draught horse at 143 lbs., 22 miles per diem and 2¾ miles per hour, and an ordinary horse 121 lbs. for 25 miles per diem and 2½ miles per hour.

As the speed of a horse increases, his power of draught diminishes very rapidly, until at last he can move only his own weight.

The following table shows the results obtained by different authors, those of Tredgold being for 6 hours' daily labor and those of Wood for 10 hours;

VELOCITY. Miles per Hour.	—Force of Draught According to— Leslie.	Tredgold.	Wood.
2	100	166	125
3	81	125	83
4	64	83	62
5	49	62	50
6	36		42
7	25		36
8	16		31
9	9		28
10	4		25

From the above table it appears that, according to Wood, at 4 miles per hour a horse can draw only half his load at 2 miles; at 8 miles, only a quarter, etc.

Sir John Macneil estimates it at [illegible] lbs. moved [illegible] miles per diem at same velocity (Gillespie). "Wood's Practical Treatise on Railroads" contains an interesting chapter on horse power. He made many experiments, and quotes an interesting memorial to the House of Commons, May 3, [illegible], from the proprietors of various stage coaches running out of Liverpool, employing [illegible] horses. These horses traveled an average distance of [illegible] miles daily at a speed not exceeding [illegible] miles per hour, and the stock had to be renewed every three years.

Tredgold assigned [illegible] lbs. as the power that a horse should exert over a distance of [illegible] miles in a day at a velocity of [illegible] miles per hour for one hour [illegible]. [illegible] founded upon his experiments on stage coach horses. They endured this service only three years.

The speed of North Chicago [illegible] cars is [illegible] miles per hour, including stoppages, and the average time of service is [illegible] five years [illegible] traveling upon [illegible] paved [illegible]. [illegible] average [illegible] years per horse. The chief [illegible] Chicago [illegible] estimates the [illegible] five years.

[illegible]

[illegible] miles per [illegible]
[illegible] would indicate [illegible]
[illegible] required, while my [illegible]
[illegible] average load [illegible]
[illegible] used by me to [illegible]

[illegible] some mistake in his test. [illegible]
[illegible] as his speed is [illegible]
[illegible] exerted would be only [illegible]
[illegible] less than 5 lbs. pe
[illegible] upon a step mill.
[illegible] M. E., while emp
[illegible] Railway, made experi
[illegible] found that at an av
[illegible] feet per min
[illegible] and machiner
[illegible] car and its passen
[illegible] would equal .7
[illegible] by me. Mr. M
[illegible] average speed
[illegible] traction could
[illegible] the cars

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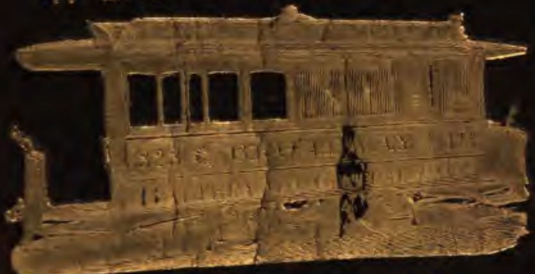

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